

Claims:

1. A catalyst for use in stationary or fluid bed dehydrogenation processes for converting hydrocarbons to olefins and / or diolefins, said catalyst comprising:

5           a carrier; chromium, in the form of  $\text{Cr}_2\text{O}_3$ , at a concentration from about 10 wt% to about 30 wt%, based on the total catalyst weight, including the  $\text{Cr}_2\text{O}_3$ ; zirconium, as a promoter, in the form of  $\text{ZrO}_2$ , at a concentration from about 0.1 wt% to  
10           about 15 wt% zirconium based on the total catalyst weight, including the  $\text{ZrO}_2$ , and magnesium, as a promoter, in the form of  $\text{MgO}$ , at a concentration from about 0.1 wt% to about 15 wt% magnesium, based on the total catalyst weight, including the  
15            $\text{MgO}$ .

2. The catalyst of Claim 1 wherein the carrier is selected from a group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, alumina-silica,  
20           silica, silicates, zeolites, bayerite, gibbsite, nordstrandite and combinations thereof.

3. The catalyst of Claim 1 wherein the carrier has a surface area of from about 15  $\text{m}^2/\text{g}$  to about 300  $\text{m}^2/\text{g}$ , a pore

volume of from about 0.2 cc/g to about 1.5 cc/g, and an average pore diameter of from about 3 nm to about 30 nm.

4. The catalyst of Claim 1 wherein the carrier has a particle size of from about 20  $\mu\text{m}$  to about 150  $\mu\text{m}$ .

5        5. The catalyst of Claim 1 wherein the carrier comprises an alumina carrier that is spray-dried or pelletized and calcined at from about 500°C to about 1100°C.

10       6. The catalyst of Claim 1 wherein the chromium promoter is derived from the group consisting of  $\text{CrO}_3$ , inorganic chromium salts, including ammonium chromate, ammonium dichromate, and chromium nitrate, organic chromium salts, and combinations thereof.

15       7. The catalyst of Claim 1 wherein the chromium promoter is present in the form of  $\text{Cr}_2\text{O}_3$  at a concentration from about 15 wt% to about 28 wt%, based on the total catalyst weight, including the  $\text{Cr}_2\text{O}_3$ .

8. The catalyst of Claim 1 wherein the chromium promoter is added in the form of a  $\text{CrO}_3$  solution that is impregnated onto the alumina carrier.

20       9. The catalyst of Claim 1 wherein the zirconium promoter is present in the form of  $\text{ZrO}_2$  at a concentration of from about 0.1 wt% to about 5 wt%, based on the total catalyst weight, including the  $\text{ZrO}_2$ .

10. The catalyst of Claim 1 wherein the zirconium promoter is present in the form of  $ZrO_2$  at a concentration of from about 0.5 wt% to about 1.5 wt%, based on the total catalyst weight, including the  $ZrO_2$ .

5 11. The catalyst of Claim 1 wherein the zirconium promoter is co-impregnated on the carrier with the chromium promoter.

10 12. The catalyst of Claim 1 wherein the magnesium promoter is present in the form of  $MgO$  at a concentration from about 0.1 to about 2 wt%, based on the total catalyst weight, including the  $MgO$ .

15 13. The catalyst of Claim 1 further comprising from about 0.3 to about 2 wt%, based on the total catalyst weight, of an alkali metal promoter, expressed in the form of an alkali metal oxide.

14. The catalyst of Claim 1 further comprising at least one additional promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

20 15. A dehydrogenation catalyst comprising:

a carrier selected from the group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina,

gamma-alumina, delta-alumina, eta-alumina,  
 bayerite, gibbsite, nordstrandite, alumina-silica,  
 silica, silicates, zeolites and combinations  
 thereof, having a surface area from about 15 m<sup>2</sup>/g  
 to about 300 m<sup>2</sup>/g, a pore volume from about 0.2  
 cc/g to about 1.5 cc/g, and an average pore  
 diameter from about 3 nm to about 30 nm.;

chromium, as a promoter, in the form of Cr<sub>2</sub>O<sub>3</sub>, at  
 a concentration from about 15 wt% to about 28 wt%,  
 based on the total catalyst weight, including the  
 Cr<sub>2</sub>O<sub>3</sub>, wherein the chromium is derived from the  
 group consisting of CrO<sub>3</sub>, ammonium chromate,  
 ammonium dichromate, chromium nitrate, organic  
 chromium salts, other inorganic chromium salts,  
 and combinations thereof;

zirconium as a promoter, calculated as ZrO<sub>2</sub>, at a  
 concentration from about 0.1 wt% to about 5 wt%  
 zirconium, based on the total catalyst weight,  
 including the ZrO<sub>2</sub>; and

magnesium as a promoter, calculated as MgO, at a  
 concentration from about 0.1 to about 2 wt%, based  
 on the total catalyst weight including the MgO.

16. The catalyst of Claim 15 wherein the chromium promoter is present at a concentration from about 17 wt% to about 24 wt%, based on the total catalyst weight, including the  $\text{Cr}_2\text{O}_3$ .

5 17. The catalyst of Claim 15 wherein the chromium is added in the form of a  $\text{CrO}_3$  solution that is impregnated onto the alumina carrier.

10 18. The catalyst of Claim 15 wherein the zirconium promoter in the form of  $\text{ZrO}_2$  is present at a concentration from about 0.5 wt% to about 1.5 wt%, based on the total catalyst weight, including the  $\text{ZrO}_2$ .

15 19. The catalyst of Claim 15 wherein the magnesium promoter in the form of  $\text{MgO}$  is present at a concentration from about 0.5 to about 1 wt%, based on the total catalyst weight, including the  $\text{MgO}$ .

20. The catalyst of Claim 15 wherein the zirconium is co-impregnated on the carrier with the chromium and the magnesium.

20 21. The catalyst of Claim 15 further comprising from about 0.3 to about 2 wt%, based on the total catalyst weight, of an alkali metal promoter, expressed in the form of an alkali metal oxide.

22. The catalyst of Claim 15 further comprising at least one promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

5        23. The catalyst of Claim 15 used for dehydrogenation in a stationary or fluid bed.

24. A dehydrogenation catalyst comprising:

10        a carrier, selected from the group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, bayerite, gibbsite, nordstrandite, alumina-silica, silica, silicates, zeolites and combinations thereof, and having a surface area from about 15

15        m<sup>2</sup>/g to about 300 m<sup>2</sup>/g, a pore volume from about 0.25 cc/g to about 0.35 cc/g, and an average pore diameter from about 3 nm to about 30 nm., wherein said carrier is spray-dried or pelletized and calcined;

20        chromium as a promoter, in the form of Cr<sub>2</sub>O<sub>3</sub>, at a concentration from about 17 wt% to about 24 wt%, based on the total catalyst weight, including the Cr<sub>2</sub>O<sub>3</sub>, wherein said chromium is derived from the

group consisting of  $\text{CrO}_3$ , ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, other inorganic chromium salts, and combinations thereof, wherein said chromium is added to the support in the form of a  $\text{CrO}_3$  solution that is impregnated onto the carrier; an alkali metal as promoter, calculated as an alkali metal oxide, at a concentration from about 0.3 wt% to about 2 wt%, based on the catalyst weight, including the alkali metal oxide; zirconium as a promoter, calculated as  $\text{ZrO}_2$ , at a concentration from about 0.5 wt% to about 1.5 wt% zirconium, based on the total catalyst weight, including the  $\text{ZrO}_2$ ; and magnesium as a promoter, calculated as  $\text{MgO}$ , at a concentration from about 0.5 wt% to about 1 wt% magnesium, wherein the magnesium is co-impregnated on the carrier with the chromium and zirconium.

25. The catalyst of Claim 24 further comprising at least one promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

26. The catalyst of Claim 24 used for dehydrogenation in a stationary or fluid bed.

27. The catalyst of Claim 24 wherein the alkali metal promoter comprises about 0.3 to about 1 wt%  $\text{Na}_2\text{O}$ , based on the total catalyst weight, including the  $\text{Na}_2\text{O}$ .

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